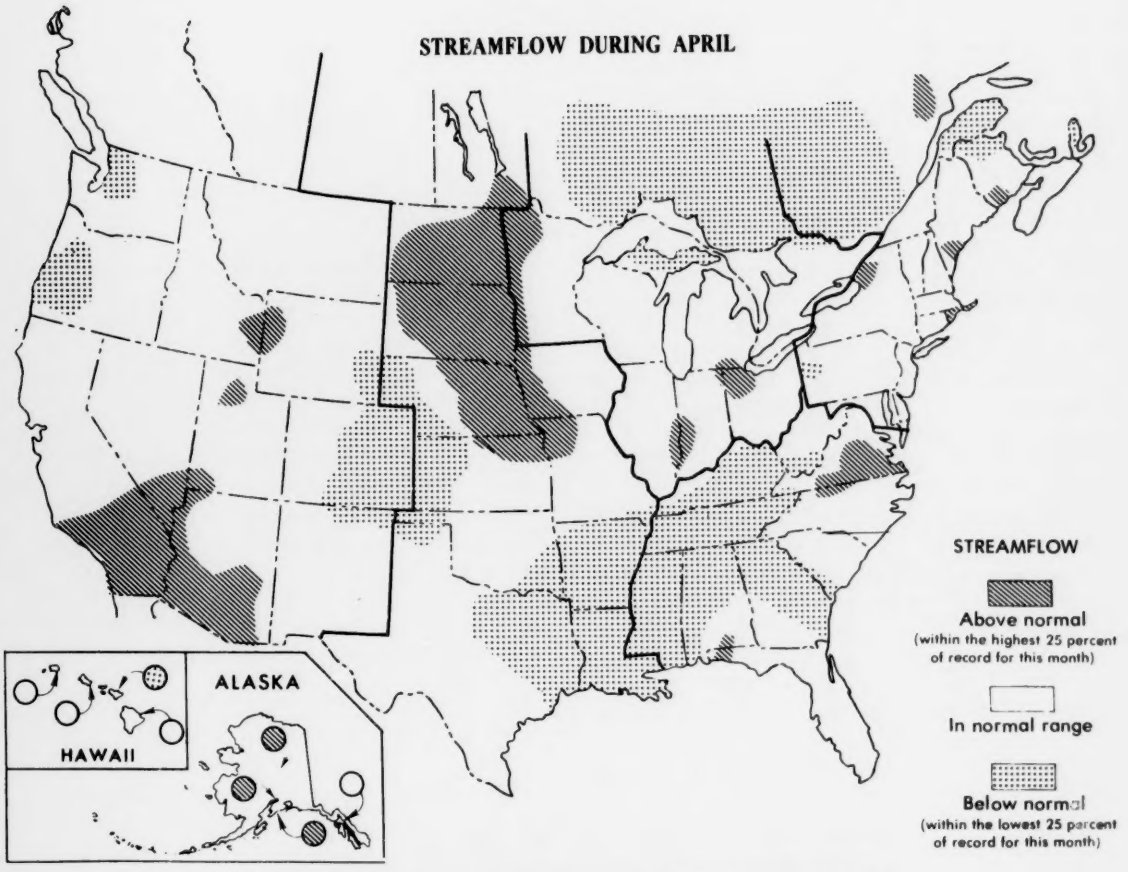
WATER RESOURCES REVIEW for APRIL 1978

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH



STREAMFLOW AND GROUND-WATER CONDITIONS

Streamflow increased seasonally in southern Canada and in most northern and western States, decreased in many eastern and central States, and was variable elsewhere, including Alaska and Hawaii.

Severe flooding occurred in southern Virginia and in Red River of the North basin in North Dakota and adjacent areas in Minnesota. Large areas of above-normal streamflow persisted in southwestern and north-central sections of the United States. Monthly and daily mean discharges were highest of record for the month in parts of Minnesota.

Below-normal streamflow persisted in Louisiana and parts of adjacent States and also southeastern Canada and parts of Kansas, Michigan, and Oregon. Monthly and daily mean flows were lowest of record for April in parts of Louisiana.

Ground-water levels continued to rise in the mid-Northeast, declining elsewhere in the Northeast; levels continued near or above average. Mixed trends prevailed in the Southeast, and generally rose in the Western Great Lakes Region except in Ohio; levels were above and below average. In the Mid-continent Region, levels rose in the northern part, and were generally above average; levels declined in the south, where levels were generally below average. Trends were generally mixed in the West, with above- and below-average levels.

New high levels for April were recorded in Iowa and Nevada, and new lows in Arizona, Arkansas, Georgia, New Mexico, southern California, and Tennessee. New alltime lows occurred in Idaho, Louisiana, and Texas.

INDEX OF STREAMFLOW

During March and April, there were no large areas of the United States that indicated persistent patterns of above- or below-normal streamflow and the index of streamflow for each region ranged between the values of 1 and -1. Inasmuch as index values that fall within that range are considered normal, this feature in the Water Resources Review will be discontinued until persistent patterns of above- or below-normal streamflow recur.

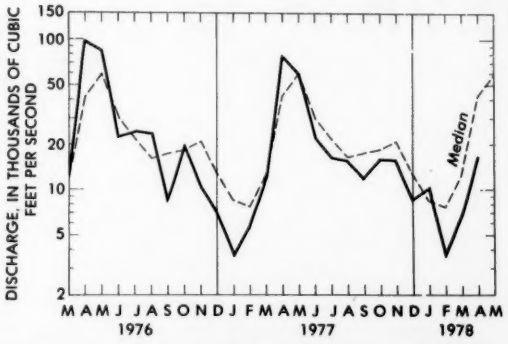
NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New Jersey, New York, Pennsylvania, and the New England States]

Streamflow generally increased seasonally in northern parts of the region and decreased seasonally in Connecticut, Maryland, New Jersey, Pennsylvania, and parts of New York. Monthly mean discharges remained in the below-normal range in parts of Quebec and the Atlantic Provinces and decreased into that range in parts of Pennsylvania. Flows increased into the above-normal range in Rhode Island and parts of Maine, Massachusetts, New York, New Brunswick, and Quebec.

Ground-water levels continued to rise in most of New York, Delaware, eastern Maryland and Pennsylvania, and in northern New England; they declined in most coastal areas of New England and in western Pennsylvania and Maryland. Levels remained near or above average.

In Quebec, streamflow increased seasonally but was generally below the normal range in the southwestern part of the Province as a result of below-normal temperatures and precipitation that caused a late breakup. North of the St. Lawrence River, in the St. Maurice River basin, streamflow as measured at Grand Mere remained in the below-normal range for the 3d consecutive month and was only 40 percent of the median flow for April. (See graph.) Also in southwestern Quebec, monthly mean flows at Coulonge River near



Monthly mean discharge of St. Maurice River at Grand Mere, Quebec (Drainage area, 16,300 sq mi; 42,220 sq km)

Fort-Coulonge and Harricana River at Amos increased but remained in the below-normal range for the 2d consecutive month. In the eastern part of the Province, where streamflow in Matane River near Matane was in the normal range and 75 percent of median in March, flow increased but was below the normal range in April at 30 percent of median. Also in eastern Quebec, monthly mean flow in Outardes River at Outardes Falls increased sharply from the below-normal range in March and was in the above-normal range during April.

In northern New Brunswick, the increase in streamflow at Upsalquitch River at Upsalquitch was less than normal and flow at that site was in the below-normal range during April. In the southern part of the Province, where monthly mean flow in March at Lepreau River at

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Lepreau was below the normal range and only 57 percent of median, streamflow increased sharply to 124 percent of median in April and was above the normal range. In northern Nova Scotia, monthly mean discharge in Northeast Margaree River at Margaree Valley increased but was below the normal range. Elsewhere in Nova Scotia, mean flows increased and were generally in the normal range.

In southern Maine, monthly mean flow in Little Androscoggin River near South Paris increased sharply from the normal range during March and was in the above-normal range. Elsewhere in the State, streamflow increased but remained in the normal range. Monthend flows at all index stations, however, were well above the normal range.

In central New England, monthly mean flows were generally in the normal range except in Rhode Island and southeastern Massachusetts where above-normal flows prevailed. At Branch River at Forestdale, R.I., for example, streamflow increased and remained above median for the 8th consecutive month and was above the normal range.

In Connecticut, monthly mean flows decreased seasonally but were within the normal range. Cumulative runoff since October 1, 1977 was well above the normal range at all index stations, however.

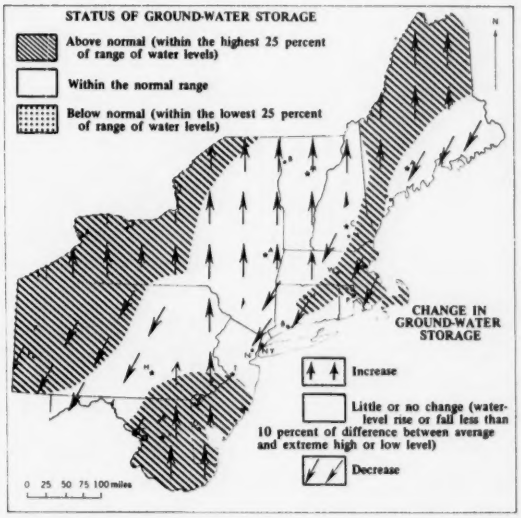
In northern New York, flow in West Branch Oswegatchie River at Harrisville increased sharply and was above the normal range. Mean discharge at that index station was above the normal range during 5 of the first 7 months of the 1978 water year. Elsewhere in the State, streamflow generally increased seasonally and flows were in the normal range as a result of a gradual melting of the snow cover.

In western Pennsylvania, where monthly mean flow in Allegheny River at Natrona was in the normal range and 87 percent of median in March, flow decreased sharply as a result of below-normal precipitation and was below the normal range at only 20 percent of median. Elsewhere in the State, high carryover flow from March generally held monthly mean flows in the normal range during April.

In New Jersey, where precipitation during April was reportedly well below normal, high carryover flow from March held monthly mean discharges in the normal range at all index stations.

In Maryland and Delaware, streamflow decreased seasonally throughout the bistate area. In Choptank River near Greensboro, Md., where mean flow in March was highest of record for the month, the monthly mean discharge in April was in the normal range at 103 percent of median.

Ground-water levels rose in northern Maine and New Hampshire, and in most of Vermont and New York State. (See map.) Levels rose also in Delaware, eastern Maryland and Pennsylvania, and in adjoining parts of New Jersey. Levels declined in western Maryland and most of western Pennsylvania, as well as in most of Connecticut, Massachusetts, and coastal Maine. Levels near end of month were again near or above average in most of the region.



Map shows ground-water storage near end of April and change in ground-water storage from end of March to end of April.

SOUTHEAST

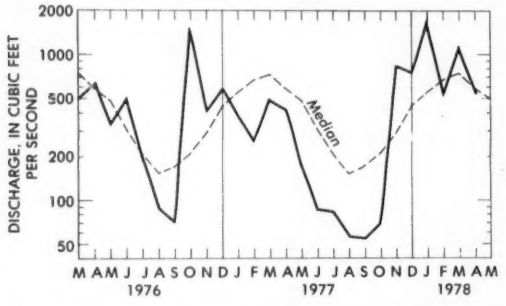
[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

Streamflow decreased seasonally in all parts of the region except in southern Virginia where runoff from heavy rains near monthend resulted in flooding and in monthly mean flows greater than in March. Flooding occurred also in parts of North Carolina but mean flows generally were less than in March. Monthly discharges remained in the below-normal range in parts of Alabama and Mississippi, and decreased into that range in Kentucky and Tennessee and parts of Georgia and West Virginia.

Ground-water levels generally declined in West Virginia, Virginia, Tennessee, Mississippi, Alabama, and Florida; rose in Kentucky; and showed mixed trends in North Carolina and Georgia. Levels were above average in Kentucky and in most of North Carolina, generally below average in Alabama and Florida, and were above

and below average in West Virginia, Virginia, and Florida. New lows for April were reached in Tennessee and Georgia.

In south-central Virginia, severe flooding along Roanoke River near monthend forced many residents to evacuate their homes. The peak stage of 18.95 feet on April 27 at the gaging station at Roanoke (drainage area, 395 square miles) was only 0.66 foot lower than the crest of the flood of June 21, 1972, and the associated discharge of 24,000 cfs was equivalent to that of a 50-year flood. In the southeastern part of the State, flooding occurred along the James, Meherrin, and Nottaway Rivers, where peak discharges ranged from less than that of a 10-year flood (on James and Nottaway) to about that of a 25-year flood on Meherrin River near Lawrenceville. The monthly mean flow in Nottaway River near Stony Creek decreased from the unusually high mean flow of March but remained above the normal range for the 6th time in the past 7 months. In northern Virginia, mean flow in Rapidan River near Culpeper also decreased sharply from the high flow of March but was near median and within the normal range. (See graph.)



Monthly mean discharge of Rapidan River near Culpeper, Va. (Drainage area, 472 sq mi; 1,222 sq km)

In southeastern West Virginia, where monthly mean flow in Greenbrier River at Alderson was in the above-normal range and 171 percent of median in March, flow decreased sharply into the below-normal range and was only one-half of the median flow for April. Elsewhere in the State, mean flows decreased seasonally, were near median, and were within the normal range.

In Kentucky, monthly mean flows decreased sharply, as a result of below-normal precipitation, were below the normal range, and generally were less than one-half the April median flows.

In Tennessee, where precipitation across the State was reported to be about one-half of normal for the month, mean discharges also decreased sharply and were in the below-normal range in all parts of the State. Monthly flows in Emory River at Oakdale and Harpeth River at Kingston Springs were only one-third the April median flows for those sites.

In Mississippi, mean flows also decreased sharply and were below the normal range in all parts of the State. In central and northeastern Mississippi, monthly mean discharges in Big Black River near Bovina and Tombigbee River at Columbus were only 15 and 21 percent, respectively, of the April median flows for those stations. In the southeastern part of the State, mean flow in Pearl River, as measured at Bogalusa, La., near the Mississippi-Louisiana boundary, and Pascagoula River at Merrill, continued to decrease and were below the normal range.

In northern and central Alabama, respectively, mean flows in Tombigbee River at Demopolis lock and dam, near Coatopa, and Cahaba River at Centreville decreased sharply, were about one-third median, and remained below the normal range for the 3d consecutive month. In the southern part of the State, monthly mean discharge in Conecuh River at Brantley also decreased seasonally but was near median and remained in the normal range for the 3d consecutive month.

In east-central and northern Georgia, monthly mean flows decreased sharply from those of March and were below the normal range. For example, in the east-central part of the State, mean discharge in Altamaha River, one of the larger streams in the State, was 48 percent less than in March at the index station at Doctortown (drainage area, 13,600 square miles), although the normal seasonal decrease from March to April is only 6 percent. In extreme northern Georgia, mean flow in Etowah River at Canton also decreased and was in the below-normal range for the first time since July 1977. In the Apalachicola River basin in western Georgia and the adjacent areas of Alabama and Florida, mean flow as measured at Chattahoochee, Fla., at the Georgia-Florida boundary, was 42 percent less than in March although the normal seasonal decrease at that site is only 16 percent.

In Suwannee River basin, in southern Georgia and the adjacent area of northwestern Florida, monthly mean flows decreased and were in the normal range. In Alapaha River (tributary to Suwannee River) at Statenville, Ga., mean flow was 69 percent less than in March although the normal seasonal decrease is only 6 percent. Downstream, mean flow in Suwannee River at Branford, Fla. decreased 32 percent from the March flow, in contrast to a normal seasonal increase in flow of 4 percent. In extreme northwestern Florida, monthly mean flow in Shoal River near Crestview remained above the normal range for the 5th time in the past 6 months

and was 226 percent of the April median flow. Cumulative runoff at this station during the first 7 months of the 1978 water year was 187 percent of median. In west-central Florida, mean flow in Peace River at Arcadia decreased 87 percent from the flow of March, compared to the normal seasonal decrease of 27 percent, and was only 34 percent of median.

In South Carolina, mean flows also decreased by more than the normal seasonal amounts but remained in the normal range. In the northeastern part of the State, monthly mean flow in Pee Dee River at Peedee was 34 percent less than in March, in contrast to the normal seasonal decrease of 9 percent.

In North Carolina, monthly mean flows decreased seasonally and were in the normal range in all parts of the State. Flows generally increased near monthend as a result of runoff from rains that began about April 25. Minor flooding occurred along the larger streams, and was more severe along the smaller streams, in the eastern Piedmont and Coastal Plain.

Ground-water levels declined statewide in West Virginia, were below average in the central and southern parts of the State, and above average elsewhere. In Kentucky, levels rose and were above average in most areas. In Virginia, levels declined in all three key observation wells, but were above average except in the Tyler well in Louisa County, which was nearly 2 feet below average. In western Tennessee, the artesian level in the key well in the "500-foot sand" near Memphis declined slightly and was at a new low for April; the level continued more than 15 feet below average. In North Carolina, levels rose in the mountains and eastern Piedmont, and declined in the remainder of the State; levels were below average in the eastern Piedmont and above average elsewhere. In Mississippi, levels declined in both the Sparta Sand and Cockfield Formation in the Jackson area, and levels in both aquifers were well below those of a year ago. Levels declined also in wells screened in the Gordo and Eutaw Formations in the northeastern part of the State. In Alabama, levels declined about a foot and were below average. In Georgia, levels in the Piedmont declined slightly during the month. In the coastal counties, levels declined 1 to 2 feet in the principal artesian aquifer. The artesian level in the Cockspur Island well in the Savannah area declined ½ foot and was at a new April low in 22 years of record. In southwestern Georgia, levels declined 1 to 5 feet. Levels declined in most parts of northern Florida, and were below average in west-central Polk County but slightly above average near Ocala. In southeastern Florida, levels held fairly steady in Dade and Broward Counties but declined about ½ foot in Palm Beach County, ranging from average to about a foot below average.

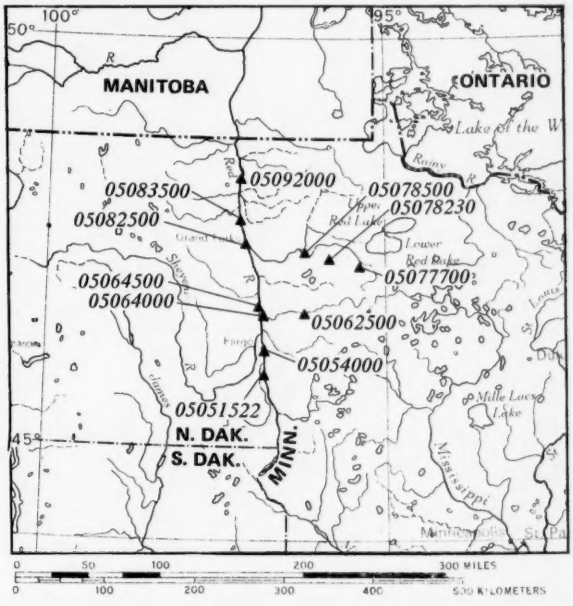
WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

Streamflow generally increased seasonally except in Indiana, Ohio, and parts of Illinois, where flows decreased from the above-normal flows of March. Monthly mean discharges remained above the normal range in parts of Indiana and Ohio, and were highest of record for April in part of Minnesota. Major flooding occurred in northwestern Minnesota but the spring breakup and snowmelt runoff was gradual in other northern States of the region and did not cause significant flooding. Monthly flows remained below the normal range in parts of Michigan and Ontario.

Ground-water levels rose in Michigan, Illinois, and Indiana, generally rose in Minnesota, and declined in Ohio. Levels were below average in Michigan, above and below average in Minnesota, and above average in Illinois, Indiana, and Ohio.

Flooding along Red River of the North, which forms much of the boundary between North Dakota and Minnesota, began near the end of March in North Dakota when tributaries that join Red River of the North near West Fargo overflowed their banks. This flooding continued into April and expanded to include tributaries in Minnesota. Peak discharges were highest of record on Wild Rice River at Hendrum (35 years), Ruffy Brook near Gonvick (18 years), and Clearwater River at Red Lake Falls (51 years). On Wild Rice River at Twin Valley, the peak discharge was second highest in 55 years of record. Selected data on stages, discharges, recurrence intervals, and gaging station locations, are given in the accompanying map, and table (on page 6). Peak discharge on Buffalo River, tributary to Red River of the North about 15 miles upstream from the mouth of



Location of stream-gaging stations in Minnesota and North Dakota described in table of peak stages and discharges.

(Continued on page 8.)

FLOOD DATA FOR SELECTED SITES IN NORTH DAKOTA AND MINNESOTA, APRIL 1978

WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
	NORTH DAKOTA										
	RED RIVER OF THE NORTH BASIN										
05051522	Red River of the North near Hickson	4,300	1975–	Mar. 31, 1976	[a]16.94	2,500	Apr. 1	33.52	9,000	2.1	.....
05054000	Red River of the North at Fargo	6,800	1901–	Apr. 15, 1969	37.34	25,300	2	34.41	17,500	2.6	30
05082500	Red River of the North at Grand Forks	30,100	1882–	Apr. 10, 1897	[b]50.2	80,000	11	45.65	54,000	1.8	40
05092000	Red River of the North at Drayton	34,800	1936–37, 1941–	May 12, 1950	[b]41.58	86,500	16	41.19	56,200	1.6	20
	MINNESOTA										
	RED RIVER OF THE NORTH BASIN										
05062500	Wild Rice River at Twin Valley	888	1909–17, 1930–	July 22, 1909	[b]20.0	9,200	7	13.64	6,470	7.3	55
05064000	Wild Rice River at Hendrum	1,600	1944–	Apr. 15, 1969	31.42	8,300	10	31.35	9,300	5.8	50
05064500	Red River of the North at Halstad	21,800	1936–37, 1942–	July 10, 1975	38.55	39,900	9	37.61	29,000	1.3	20
05077700	Ruffy Brook near Gonvick	45.2	1960–	Mar. 30, 1967	6.35	453	6	[a]5.76	[c]470	10.4	10
05078230	Lost River at Oklee	266	1950, 1960–	Apr. 11, 1969 Apr. 21, 1950	14.91 [d]18.39	3,210 2,740	9	16.68	3,100	11.7	9
05078500	Clearwater River at Red Lake Falls	1,370	1909–17, 1934–	Apr. 12, 1969	11.82	9,740	9	11.56	9,860	7.2	30
05083500	Red River of the North at Oslo (discontinued site)	31,200	1936–37, 1941–43, 1945–60, 1969	May 10, 1950 1969	[b]31.83 36.92	63,000 56,500	12	37.91	56,200	1.8	40

[a]Backwater from ice.
[b]At site and datum then in use.
[c]about
[d]Maximum stage known since at least 1897.

Wild Rice River, was appreciably less than the maximum of record at the index station near Dilworth (drainage area, 1,040 square miles), but the monthly mean discharge of 1,950 cfs at that station was highest for April since records began in March 1931, and was 4 times the April median discharge. Elsewhere in the State, mean flows increased seasonally and were well above median but were within the normal range.

In Wisconsin, the spring breakup was uniquely moderate and orderly and the usual floodflows did not occur. Monthly mean discharges increased seasonally in all parts of the State and were near or slightly greater than median except in the east-central basin of Fox River where mean flow at Rapide Croche Dam, near Wrightstown, was below the normal range in March and increased less than normal in April, resulting in a monthly mean discharge only 57 percent of median for the month. In northern Wisconsin, where monthly mean discharge in Oconto River near Gillett was below the normal range in March, flow increased sharply and was in the normal range and greater than the median flow for the month. (See graph on page 8.)

In southwestern Ontario, monthly mean flow in English River at Umfreville increased seasonally, but far

(Continued on page 8.)

SELECTED DATA FOR THE GREAT LAKES, GREAT SALT LAKE, AND OTHER HYDROLOGIC SITES

GREAT LAKES LEVELS

Water levels are expressed as elevations in feet above International Great Lakes Datum 1955

(Data furnished by National Ocean Survey, NOAA, via U.S. Army Corps of Engineers office in Detroit. To convert data to elevations above mean sea level datum of 1929, add the following values: Superior, 0.96; Michigan-Huron, 1.20; St. Clair, 1.24; Erie, 1.57; Ontario, 1.22.)

Lake	April 30, 1978	Monthly mean, April		April		
		1978	1977	Average 1900–75	Maximum (year)	Minimum (year)
Superior (Marquette, Mich.)	600.20	600.18	599.91	600.03	601.14 (1951)	598.23 (1926)
Michigan and Huron (Harbor Beach, Mich.)	578.54	578.42	578.54	577.99	580.32 (1973)	575.36 (1964)
St. Clair (St. Clair Shores, Mich.)	574.68	574.77	574.33	573.28	575.91 (1973)	571.09 (1901)
Erie (Cleveland, Ohio)	572.35	572.26	571.55	570.51	573.30 (1973)	568.20 (1934)
Ontario (Oswego, N.Y.)	246.60	246.29	245.09	245.01	247.69 (1973)	242.38 (1935)

GREAT SALT LAKE

Alltime high: 4,211.6 (1873). Alltime low: 4,191.35 (October 1963).	April 30, 1978	April 30, 1977	Reference period 1904–77		
			April average, 1904–77	April maximum (year)	April minimum (year)
Elevation in feet above mean sea level:	4,200.10	4,200.65	4,199.0	4,205.1 (1924)	4,192.75 (1963)

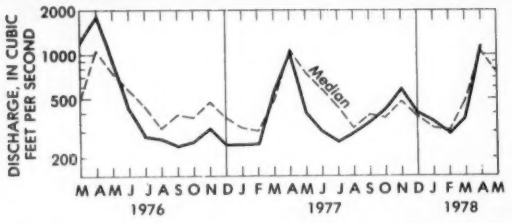
LAKE CHAMPLAIN, AT ROUSES POINT, N.Y.

Alltime high (1827–1977): 102.1 (1869). Alltime low (1939–1977): 92.17 (1941).	April 28, 1978	April 30, 1977	Reference period 1939–75		
			April average, 1939–75	April max. daily (year)	April min. daily (year)
Elevation in feet above mean sea level:	100.52	99.73	98.12	101.51 (1976)	94.11 (1965)

FLORIDA

Site	April 1978		March 1978	April 1977
	Discharge in cfs	Percent of normal	Discharge in cfs	Discharge in cfs
Silver Springs near Ocala (northern Florida)	900	119	770	780
Miami Canal at Miami (southeastern Florida)	197	518	325	84.4
Tamiami Canal outlets, 40-mile bend to Monroe	93	6,200	442	0

(Continued from page 6.)



Monthly mean discharge of Oconto River near Gillett, Wis. (Drainage area, 678 sq mi; 1,756 sq km)

less than normal, resulting in a mean discharge in the below-normal range for the first time since June 1977. In the eastern part of the Province and north of Lake Huron, mean flow in Missinaibi River at Mattice also increased seasonally, but far less than normal, and remained below the normal range at only 7 percent of the April median. In extreme southeastern Ontario, where mean flow in Saugeen River near Port Elgin was below the normal range and only ½ of median in February and March, monthly mean discharge increased sharply, was 126 percent of median and was within the normal range.

In Michigan, monthly mean flow in Sturgeon River near Sidnaw, in the Upper Peninsula, increased seasonally, but because of freezing temperatures at night and only moderate temperatures during the day, the rate of snowmelt runoff was below normal and the resulting mean discharge was in the below-normal range. In the Lower Peninsula, discharges in Red Cedar River at East Lansing and Muskegon River at Evart were above median and within the normal range.

In northwestern Ohio, flooding occurred along Maumee River in March and monthly and daily mean discharges were highest of record for that month at Waterville. High carryover flow, augmented by increased runoff from rain early in April, resulted in the 2d consecutive month of mean discharge in the above-normal range at that index station. Elsewhere in the State, monthly mean flows decreased seasonally and were in the normal range.

In Indiana, monthly mean discharge decreased seasonally at all index stations in the State. High carryover flow from March in Wabash River, as measured at Mt. Carmel, Ill., contributed to the 2d consecutive month of above-normal flow at that site. In eastern Indiana, mean flow in East Fork White River at Shoals was 57 percent less than the mean flow in March, in contrast to the normal seasonal decrease of 10 percent at that site, but was within the normal range. Also in the eastern part of the State, flow in Mississinewa River at Marion decreased into the normal range.

In Illinois, flows generally decreased in the southern part of the State and increased in the northern part, but were in the normal range. In extreme northern Illinois, where mean flow in Pecatonica River at Freeport was below the normal range and only ½ of median in March, mean discharge increased, was 122 percent of median and in the normal range. In contrast, in the southern part of the State, where mean flow in Skillet Fork at Wayne City was above the normal range and nearly 3 times median in March, flow decreased sharply to 42 percent of median in April.

Ground-water levels in shallow water-table wells in Minnesota rose and were above average in the southern part of the State; levels rose slightly but remained below average in the northern part. In the Minneapolis-St. Paul area, artesian levels rose slightly in wells tapping the Prairie du Chien-Jordan aquifer and declined slightly in the deeper Mt. Simon-Hinckley aquifer; both remained below average. In Michigan, levels rose statewide but continued mostly below average. In Illinois, the level in the shallow index well in glacial drift at Princeton, in Bureau County, rose more than 3 feet and continued above average. In Indiana, levels continued their seasonal rise and were slightly above average by month's end. Levels in Ohio declined but continued above average.

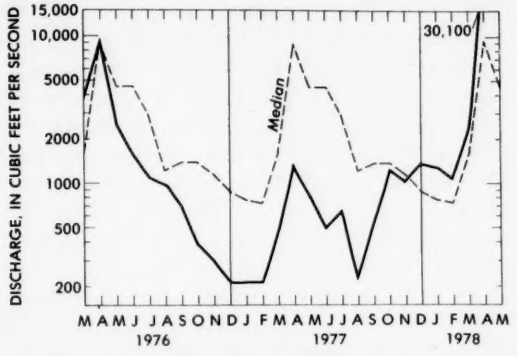
MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

Streamflow decreased in Arkansas, Kansas, Louisiana, Nebraska, and South Dakota, increased in Manitoba, Saskatchewan, Iowa, and Oklahoma, and was variable elsewhere in the region. Flows remained above the normal range in parts of Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota, and remained below the normal range in parts of Arkansas, Louisiana, and Texas. Monthly and daily mean flows were lowest of record in northern Louisiana. Flooding continued along Red River of the North in North Dakota and was described as equaling the worst of this century.

Ground-water levels rose in North Dakota, Nebraska, and Iowa, and were above average in those States except in irrigation wells in Nebraska. Levels mostly declined in Louisiana and Texas, and trends were mixed in Kansas and Arkansas; levels were mostly below average in Arkansas and Louisiana and were above and below average in Kansas and Texas. There was a new high for April in Iowa, two new April lows in Arkansas, a new alltime low in Louisiana, and two new alltime lows in Texas.

The flooding that began near the end of March in Red River of the North basin near West Fargo, North Dakota continued downstream in April and expanded to include tributaries in Minnesota. As the flood crest moved slowly down the valley, thousands of acres of agricultural land were inundated at any one time during the month. Diking, however, kept most urban areas free of flood waters. Gage height and discharge records of floods on Red River of the North at Grand Forks, North Dakota were started in 1882 and the peak discharge of the flood of April 18 of that year was 68,000 cfs, gage height, 48.0 feet. The flood of April 24, 1893 crested at gage height, 45.5 feet, discharge, 53,300 cfs. The greatest flood of record at Grand Forks occurred April 10, 1897, gage height, 50.2 feet, discharge, 80,000 cfs. In the present century, the flood of May 12, 1950 crested at gage height, 45.61 feet, discharge, 54,000 cfs, and the flood of April 16, 1969 crested at gage height, 45.69 feet, discharge, 53,500 cfs. The current flood crested at Grand Forks on April 11 at gage height, 45.65 feet, discharge, 54,000 cfs, and is, therefore, equal to the worst floods observed at Grand Forks in this century, but was appreciably less than the floods of 1882 and 1897. Monthly mean discharge at Grand Forks increased seasonally, was 3½ times the April median, and remained in the above-normal range. (See graph.) Selected data on stages, discharges, recurrence intervals, and gaging station locations are given in the table and map on pages 5 and 6. In southwestern North Dakota, monthly mean flow in Cannonball River at Breien decreased seasonally but remained above the normal range and was 9 times the April median flow.



Monthly mean discharge of Red River of the North at Grand Forks, N. Dak (Drainage area, 30,100 sq mi; 78,000 sq km)

In central South Dakota, where monthly and daily mean flows in March on Bad River at Fort Pierre were highest for that month since records began in 1928, flow decreased sharply but, as a result of high carryover flow from March, augmented by increased runoff from rains near midmonth, remained in the above-normal range and was 3½ times the median flow for April. In the eastern part of the State, mean flow in Big Sioux River, as measured at Akron, Iowa, also decreased seasonally, was 3½ times median, and remained above the normal range.

In eastern Nebraska, mean flow in Elkhorn River at Waterloo remained in the above-normal range and was 219 percent of the April median flow, as a result of high carryover flow from March, augmented by increased runoff from rains early in the month. In the northwestern part of the State, monthly mean flow in Niobrara River above Box Butte Reservoir decreased seasonally and was below the normal range for the 5th time in the past 7 months. In the Panhandle and southwestern parts of the State, flows generally were below normal.

In southwestern Iowa, monthly mean discharge in Nishnabotna River above Hamburg remained above the normal range as a result of high carryover flow from March, augmented by increased runoff from rains near midmonth. Elsewhere in the State, mean flows increased, were near or above median flows for April, and were in the normal range.

In northwestern Missouri, mean flow in Grand River near Gallatin also remained above the normal range as a result of high carryover flow from March and increased runoff near midmonth, and was 5 times the April median discharge. In the southern part of the State, monthly mean flow in Gasconade River at Jerome decreased sharply from the high flow of March, was less than the April median discharge, and was in the normal range.

In northeastern Kansas, monthly mean flow in Little Blue River near Barnes remained in the above-normal range as a result of high carryover flow from March, augmented by increased runoff from rains near midmonth. Increased runoff occurred also in Delaware River and Stranger Creek in northeastern Kansas. In the southwestern part of the State, mean flow in Arkansas River at Arkansas City decreased from the unusually high flow of March and was in the normal range. In western Kansas, monthly mean discharge in Saline River near Russell also decreased, was only 24 percent of the April median flow, and remained in the below-normal range for the 7th consecutive month.

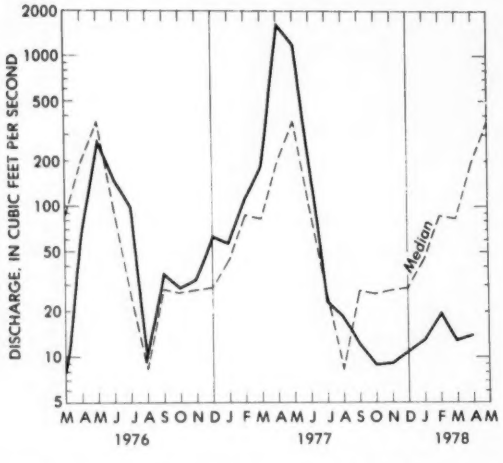
In Oklahoma, monthly mean flows were less than median except in Neosho River basin in the northeastern part of the State, where increased runoff from intense rains in southeastern Kansas and southwestern Missouri required that the flood gates be opened at Lake O'The Cherokees, Lake Hudson, and Fort Gibson Lake. No

flooding occurred. In south-central Oklahoma, mean flow in Washita River near Durwood increased seasonally and remained within the normal range but was less than median for the 10th consecutive month.

In northern Arkansas, where mean flow in Buffalo River near St. Joe was above the normal range and 2 times the median flow in March, flow decreased in April, was in the below-normal range, and was only ½ of the median flow for the month. In the southern part of the State, monthly mean flow in Saline River near Rye decreased seasonally, remained in the below-normal range, and was only ¼ of the April median flow.

In the adjacent area of northern Louisiana, the monthly mean discharge of 27.7 cfs and the daily mean of 10 cfs on the 24th, in Saline Bayou near Lucky (drainage area, 154 square miles) were lowest for April since records began in 1940. In the western part of the State, mean flow in Calcasieu River near Oberlin decreased seasonally, remained below the normal range, and was only 13 percent of median. In southeastern Louisiana, monthly mean discharges in Amite River near Denham Springs and Pearl River near Bogalusa also decreased seasonally and were in the below-normal range. Stages at the Bogalusa gage were above the National Weather Service flood stage of 15 feet for a few days in midmonth.

In north-central Texas, mean flow in North Bosque River near Clifton remained in the below-normal range and was only 7 percent of median. (See graph.) In the eastern part of the State, monthly mean discharge in Neches River near Rockland decreased and also remained in the below-normal range. In the southern and western parts of the State, flows increased in some streams and decreased in others but monthly mean flows remained in the normal range.



Monthly mean discharge of North Bosque River near Clifton, Tex. (Drainage area, 972 sq mi; 2,517 sq km)

In southeastern Saskatchewan, mean flow in Qu'Appelle River near Lumsden increased seasonally and remained within the normal range but was only ¼ of the April median flow.

In southern Manitoba, monthly mean flow in Waterhen River below Waterhen Lake also increased seasonally and remained in the normal range but was about ½ of the median flow for the month. The level of Lake Winnipeg at Gimli averaged 713.07 feet above mean sea level for the month, 0.08 foot lower than the long-term average for April, 0.48 foot higher than last month, and 1.41 feet higher than a year ago. The record of Lake Winnipeg levels began in May 1913 at Winnipeg Beach.

Ground-water levels in North Dakota rose statewide and were above average. Levels in Nebraska also rose, and were above average except in areas where ground water has been developed extensively for irrigation. In Iowa, levels rose in response to seasonal precipitation, and were above average. The level in the shallow water-table well at Marion, in Linn County, reached a new high level for April——1.83 feet below land surface. Levels in Kansas declined except in the eastern part of the State. In the rice-growing area of east-central Arkansas, the level in the shallow Quaternary aquifer declined slightly, and was in the same range that has prevailed since 1961. The level in the deep aquifer——the Sparta Sand——rose 3.5 feet but was 12.7 feet below average, and at a new April low in 11 years of record. In the Sparta Sand industrial aquifer of central and south Arkansas, the level in the key well at Pine Bluff rose about 1 foot, was 14.75 feet below average, and at a new April low in 12 years of record. At El Dorado the level was about 1 foot higher than last month, and was about 3.6 feet below average. In Louisiana, levels in wells in most aquifers in the southeastern part of the State appeared to be at or near spring highs and showed mixed trends. In the New Orleans area, levels in wells in the "700-foot sand" began their seasonal decline. Levels in wells in the Sparta Sand of northern Louisiana and in Miocene sands of central Louisiana continued to decline regionally. Levels in wells in the Mississippi and Red River alluvial aquifers and in the terrace aquifer reached seasonal highs and began declining. Levels in wells in the Chicot aquifer declined in most of southwestern Louisiana because of seasonal pumping for rice irrigation. The April level in the key observation well near Iowa, La., declined nearly 22 feet and reached the lowest level in 38 years of record. In Texas, levels in key wells in the Edwards Limestone declined at Austin and San Antonio and were above average. Levels in wells in the Evangeline aquifer at Houston rose slightly at Houston

but were below average; levels in wells in the bolson deposits at El Paso declined and were below average. New alltime low levels were reached in the key wells at El Paso and in the Ogallala Formation at Plainview in the Texas Panhandle.

WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

Streamflow generally increased seasonally in Alberta, British Columbia, Colorado, Idaho, Nevada, Oregon, Utah, and Wyoming, decreased in Arizona, and was variable elsewhere in the region. Above-normal flows persisted in parts of Arizona, California, and Utah, and increased into that range in southeastern Idaho. Monthly mean flows remained in the below-normal range in parts of Oregon and decreased into that range in parts of Colorado, New Mexico, and Washington. Landslides continued in many areas of southern California as a result of rains falling on saturated soil.

Ground-water levels showed mixed trends in most of the region except in Washington, southern California, and Nevada, where they generally rose. Levels were above and below average in Washington, Idaho, southern California, and Nevada, and were below average in all key wells in Montana, Utah, Arizona, and New Mexico. A new high for April occurred in Nevada, new April lows were reached in California, Arizona and New Mexico, and a new alltime low occurred in Idaho.

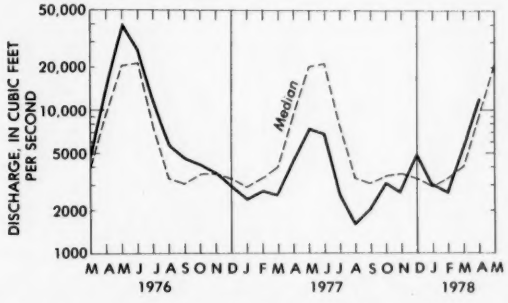
In southern California, streamflow remained in the above-normal range as a result of general storms in April that maintained the well-above-normal precipitation trend thus far in the 1978 water year. Landslides continued in many areas as a result of rains falling on the saturated soil. Following the floods and mudslides that occurred during the period February 5–March 13, thirteen counties were declared disaster areas with an estimated loss of $300 million. Monthly mean discharge at the index station, Arroyo Seco near Pasadena, remained in the above-normal range for the 4th consecutive month and was nearly 10 times the median flow for April. In northern and central parts of the State, monthly mean flows at the index stations were generally above median but within the normal range. The combined contents of 10 of the major reservoirs in northern California was 97 percent of average and more than 200 percent of that of a year ago. Releases were made at some reservoirs where inflow waters occupied parts reserved for flood storage. Water content of the snowpack at higher elevations in mountainous areas represented a potential flood threat.

In southwestern Oregon, monthly mean flow in Umpqua River near Elkton increased but remained in the below-normal range for the 2d consecutive month. In the northwestern part of the State, flow in the Willamette River at Salem also increased, was 55 percent of median, and remained in the below-normal range for the 3d consecutive month. Elsewhere in the State, streamflow generally increased and was in the normal range.

In Washington, streamflow was below median at all index stations and was generally in the normal range except for Skykomish River near Gold Bar, on the northwest slope of the Cascade range, where mean flow decreased from the above-normal range in March and was below the normal range. Storage in four of the five reporting reservoirs were near or above the average contents and near or above the amounts reported a year ago.

In Alberta and British Columbia, streamflow increased seasonally at all index stations and were near the median flows for April.

Similarly, in Montana, streamflow generally increased seasonally and monthly mean flows were in the normal range at all index stations. Typical of the statewide normal trend was the flow in Clark Fork at St. Regis, in the western part of the State – an increase in flow from March but within the normal range for April. (See graph.)



Monthly mean discharge of Clark Fork at St. Regis, Mont. (Drainage area, 10,709 sq mi; 27,736 sq km)

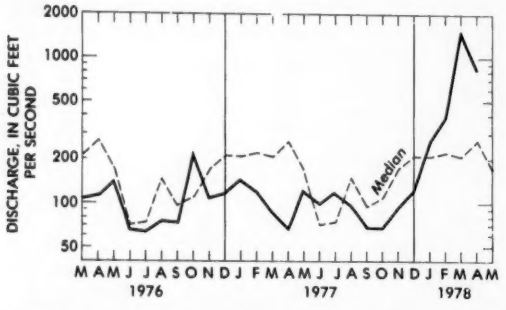
In southeastern Idaho, monthly mean flow in Snake River near Heise increased sharply to 163 percent of median and was above the normal range for the first time since October 1976. Elsewhere in the State, streamflow was generally in the normal range. Reservoir storage for irrigation continued to increase with some capacity left for the remaining snowmelt runoff.

In north-central Colorado, east of the Continental Divide, the seasonal increase in monthly mean flow at

Bear Creek at Morrison was less than normal and flow during April was below the normal range. Streamflow at the remaining index stations in the State also increased, were generally greater than median, but within the normal range.

In northern New Mexico and the adjacent area of Colorado, monthly mean flow in Rio Grande below Taos Junction Bridge, near Taos, decreased and was below the normal range for the 12th time in the past 13 months. Elsewhere in the State, flows at the index stations were variable but within the normal range.

In southern Arizona, monthly mean flow in San Pedro River at Charleston decreased sharply but, as a result of high carryover flow from March, was over 2 times median and remained in the above-normal range for the 7th consecutive month. In east-central Arizona, where monthly and daily mean flow in March in Salt River near Roosevelt were highest of record for the month, flow decreased in April but remained in the above-normal range for the 3d consecutive month. In extreme northwestern Arizona and the adjacent areas of Nevada and Utah, monthly mean flow in Virgin River at Littlefield decreased, but remained in the above-normal range for the 4th consecutive month and the daily mean discharge of 2,660 cfs on the 1st was highest for March in 48 years of record. (See graph.)



Monthly mean discharge of Virgin River at Littlefield, Ariz. (Drainage area, 5,090 sq mi; 13,180 sq km)

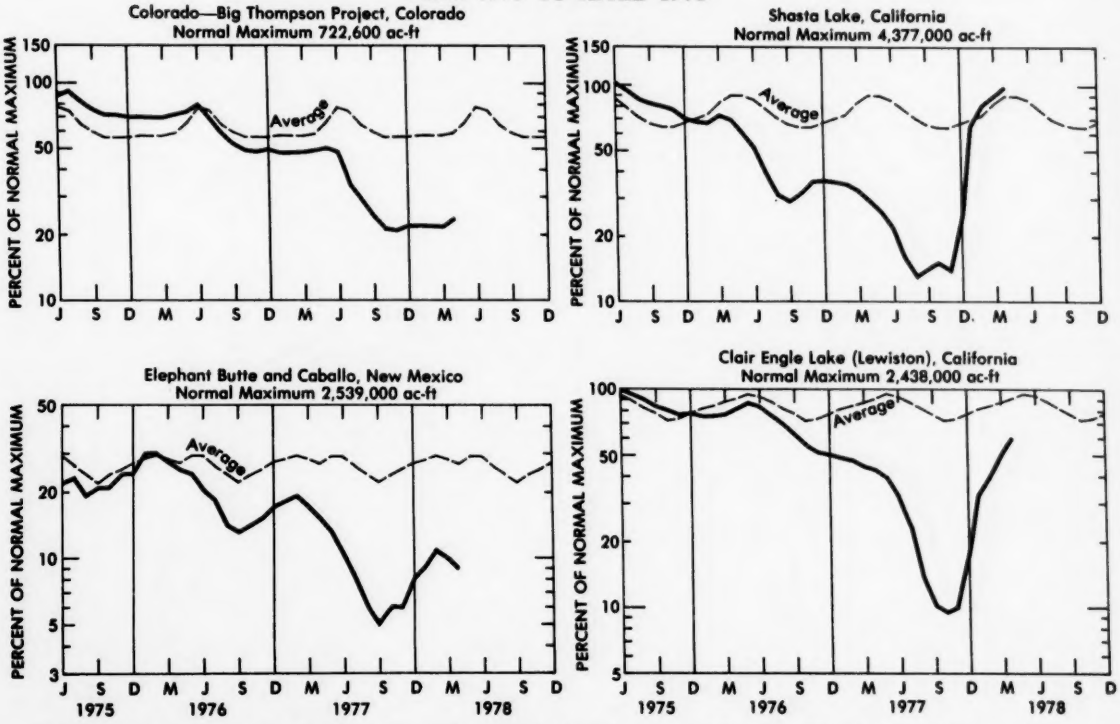
In Nevada, reservoir contents increased but continued to be below average. Monthly mean discharge at the index station, Humboldt River at Palisade, increased seasonally and remained in the normal range at 134 percent of median.

In northern Utah, monthly mean flow in Big Cottonwood Creek near Salt Lake City continued to increase seasonally and remained in the above-normal range for the 2d consecutive month. In the southwestern part of the State, mean flow in Beaver River near Beaver also increased seasonally and was above the median flow at that site for the first time since July 1975. Monthly mean flows at the remaining index stations in the State increased seasonally and were all within the normal range.

Contents of the Colorado River Storage Project increased 589,480 acre-feet during the month.

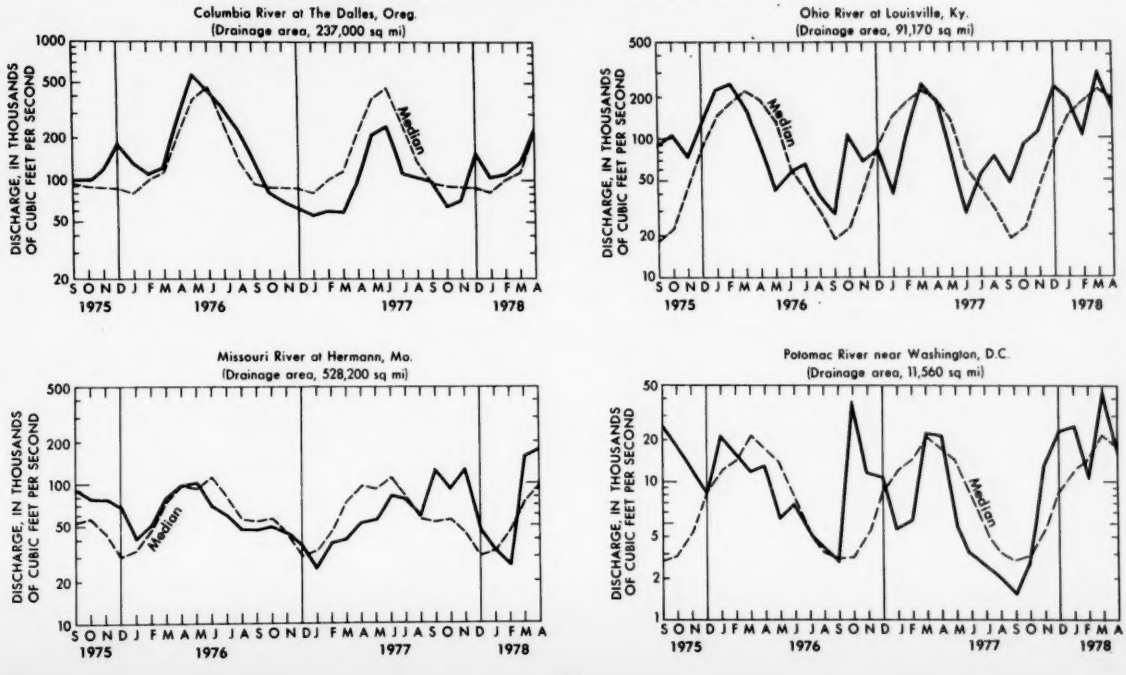
Ground-water levels in Washington rose and held steady in the eastern and western observation wells, respectively; the level continued above average in the eastern well and below in the western well. In Idaho, the level in the well in the sand and gravel aquifer in the Boise Valley declined slightly but continued slightly above average. Levels in the key wells representative of the Snake River Plain aquifer declined except at Atomic City; all were below average. The well near Eden in the southwestern part of the Plain reached a new alltime low, in 21 years of record, for the second consecutive month. The level in the key well in the alluvial aquifer underlying the Rathdrum Prairie, northern Idaho, rose slightly but continued more than 8 feet below average. In Montana, the level in the water-table well in Quaternary gravel at Missoula rose less than a foot but continued slightly below average. The level in the Hamilton Fairgrounds water-table well in alluvium declined ½ foot and continued nearly a foot below average. In southern California, levels in selected observation wells rose but were below average except in Santa Ynez Valley, Santa Barbara County, where the level in the key well at Lompoc was more than 5 feet above average. The level in the well in the upper Cuyama Valley at Cuyama, also in Santa Barbara County, was at a new low for April in 28 years of record. In Nevada, the levels in the key wells in Paradise Valley and Steptoe Valley rose and were above average; the level in the Steptoe Valley well was at a new high for April in 28 years of record. The level in the well at Truckee Meadows rose more than 2 feet but continued below average. In Utah, levels rose in wells in the Logan and Holladay areas and declined in the Flowell and Blanding areas; levels continued below average statewide. In Arizona, levels rose in two index wells and declined in three. New April lows were recorded in two of the index wells, including the Tucson no. 2 well. In New Mexico, the artesian level in the Berrendo-Smith well in the Roswell basin of the Pecos Valley declined nearly 7 feet in response to continued pumping for the new irrigation season, and continued below average. The level in the Dayton water-table well in alluvium in the southern part of the Roswell basin declined slightly and reached a new low for April in 40 years of record. The level in the Lovington well, in the southern high plains, rose slightly but continued below average and below the level of a year ago.

USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS, JUNE 1975 TO APRIL 1978



Far below-average contents continued to characterize reservoirs in various parts of the West, although dramatic increases in storage were noted in California reservoirs, including two of the four reservoirs shown in the above graphs. Good recharge was expected in most reservoirs as a result of a reported average to above-average snowpack.

HYDROGRAPHS OF FOUR LARGE RIVERS



USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF APRIL 1978

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F--Flood control I--Irrigation M--Municipal P--Power R--Recreation W--Industrial	End of Mar. 1978	End of Apr. 1978	End of Apr. 1977	Average for end of Apr.	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	64	75	90	75	226,300 (a)
QUEBEC					
Allard (P)	20	81	93	79	280,600 ac-ft
Gouin (P)	56	54	60	47	6,954,000 ac-ft
MAINE					
Seven reservoir systems (MP)	43	62	90	65	178,500 mcf
NEW HAMPSHIRE					
First Connecticut Lake (P)	[b]4	14	72	49	3,330 mcf
Lake Francis (FPR)	14	31	72	53	4,326 mcf
Lake Winnipesaukee (PR)	56	97	100	97	7,200 mcf
VERMONT					
Harriman (P)	18	70	61	77	5,060 mcf
Somerset (P)	43	61	90	74	2,500 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	70	88	95	89	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	29	90	107	90	34,270 mcf
Indian Lake (FMP)	46	68	106	91	4,500 mcf
New York City reservoir system (MW)	96	99	100	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	104	100	99	94	27,730 mg
PENNSYLVANIA					
Allegheny (FPR)	33	44	53	46	51,400 mcf
Pymatuning (FMR)	95	98	99	98	8,191 mcf
Raystown Lake (FR)	68	68	67	48	33,190 mcf
Lake Wallenpaupack (PR)	54	72	80	79	6,875 mcf
MARYLAND					
Baltimore municipal system (M)	101	100	95	94	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	90	93	92	93	12,580 mcf
Narrows (Badin Lake) (P)	99	98	95	101	5,617 mcf
High Rock Lake (P)	100	90	72	84	10,230 mcf
SOUTH CAROLINA					
Lake Murray (P)	89	94	92	82	70,300 mcf
Lakes Marion and Moultrie (P)	85	87	86	80	81,100 mcf
SOUTH CAROLINA--GEORGIA					
Clark Hill (FP)	77	77	80	76	75,360 mcf
GEORGIA					
Burton (PR)	78	91	99	92	104,000 ac-ft
Sinclair (MPR)	80	90	88	91	214,000 ac-ft
Lake Sidney Lanier (FMPR)	64	65	67	64	1,686,000 ac-ft
ALABAMA					
Lake Martin (P)	74	88	98	95	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	52	50	72	62	1,156,000 cfsd
Douglas Lake (FPR)	39	35	76	61	703,100 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	56	65	88	78	510,300 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	50	51	71	66	1,452,000 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	52	57	85	78	745,200 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	32	70	84	70	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	11	54	60	70	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	17	28	22	31	1,640,000 ac-ft
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	73	79	79	.....	22,640,000 ac-ft
SOUTH DAKOTA					
Angostura (I)	93	97	81	84	127,600 ac-ft
Bell Fourche (I)	84	97	67	70	185,200 ac-ft
Lake Francis Case (FIP)	90	87	85	83	4,834,000 ac-ft
Lake Oahe (FIP)	88	96	86	.....	22,530,000 ac-ft
MIDCONTINENT REGION--Continued					
SOUTH DAKOTA--Continued					
Lake Sharpe (FIP)	102	103	102	100	1,725,000 ac-ft
Lewis and Clarke Lake (FIP)	78	80	78	83	477,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	74	76	80	78	1,948,000 ac-ft
OKLAHOMA					
Eufaula (FPR)	99	99	91	92	2,378,000 ac-ft
Keystone (FPR)	95	94	81	113	661,000 ac-ft
Tenkiller Ferry (FPR)	120	105	100	98	628,200 ac-ft
Lake Altus (FIMR)	79	81	64	56	134,500 ac-ft
Lake O'The Cherokees (FPR)	114	98	83	91	1,492,000 ac-ft
OKLAHOMA--TEXAS					
Lake Texoma (FMPRW)	82	84	98	92	2,722,000 ac-ft
TEXAS					
Bridgeport (IMW)	63	64	100	49	386,400 ac-ft
Canyon (FMR)	95	94	100	71	385,600 ac-ft
International Amistad (FIMPW)	91	92	111	77	3,497,000 ac-ft
International Falcon (FIMPW)	84	79	100	67	2,667,000 ac-ft
Livingston (IMW)	100	99	100	78	1,788,000 ac-ft
Possum Kingdom (IMPRW)	81	87	98	97	569,400 ac-ft
Red Bluff (PI)	7	7	19	27	307,000 ac-ft
Toledo Bend (P)	92	95	99	86	4,472,000 ac-ft
Twin Buttes (FIM)	81	77	100	24	177,800 ac-ft
Lake Kemp (IMW)	61	58	82	87	268,000 ac-ft
Lake Meredith (FMW)	35	34	37	37	821,300 ac-ft
Lake Travis (FIMPRW)	77	69	100	79	1,144,000 ac-ft
THE WEST					
WASHINGTON					
Ross (PR)	31	36	12	25	1,052,000 ac-ft
Franklin D. Roosevelt Lake (IP)	37	11	30	47	5,232,000 ac-ft
Lake Chelan (PR)	22	33	44	40	676,100 ac-ft
Lake Cushman	79	84	53	88	359,500 ac-ft
Lake Merwin (P)	105	101	98	101	246,000 ac-ft
IDAHO					
Boise River (4 reservoirs) (FIP)	56	64	64	70	1,235,000 ac-ft
Coeur d'Alene Lake (P)	103	75	58	127	238,500 ac-ft
Pend Oreille Lake (FP)	39	54	49	57	1,561,000 ac-ft
IDAHO--WYOMING					
Upper Snake River (8 reservoirs) (MP)	56	64	75	74	4,401,000 ac-ft
WYOMING					
Boysen (FIP)	68	56	73	59	802,000 ac-ft
Buffalo Bill (IP)	46	48	57	61	421,300 ac-ft
Keyhole (F)	57	76	72	44	199,900 ac-ft
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	45	47	63	51	3,056,000 ac-ft
COLORADO					
John Martin (FIR)	2	0	0	14	364,400 ac-ft
Taylor Park (IR)	28	26	54	57	106,200 ac-ft
Colorado--Big Thompson project (I)	22	24	49	58	722,600 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	57	59	71	.....	31,280,000 ac-ft
UTAH--IDAHO					
Bear Lake (IPR)	56	60	74	63	1,421,000 ac-ft
CALIFORNIA					
Folsom (FIP)	67	82	30	71	1,000,000 ac-ft
Hetch Hetchy (MP)	18	25	14	36	360,400 ac-ft
Isabella (FIR)	43	51	12	28	551,800 ac-ft
Pine Flat (FI)	54	49	33	58	1,014,000 ac-ft
Clair Engle Lake (Lewiston) (P)	51	60	42	87	2,438,000 ac-ft
Lake Almanor (P)	72	79	62	56	1,036,000 ac-ft
Lake Berryessa (FIMW)	82	84	59	88	1,600,000 ac-ft
Millerton Lake (FI)	86	54	43	67	503,200 ac-ft
Shasta Lake (FIPR)	90	100	29	90	4,377,000 ac-ft
CALIFORNIA--NEVADA					
Lake Tahoe (IPR)	14	19	18	60	744,600 ac-ft
NEVADA					
Rye Patch (I)	36	43	66	95	157,200 ac-ft
ARIZONA--NEVADA					
Lake Mead and Lake Mohave (FIMP)	82	81	80	64	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	25	24	0	18	1,073,000 ac-ft
Salt and Verde River system (IMPR)	91	96	45	50	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	30	27	24	74	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	10	9	15	27	2,539,000 ac-ft

[a]Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).
[b]Reservoir drawn down for repairs

Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING APRIL 1978

Station number*	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1970 (cfs)	April 1978					
				Monthly discharge (cfs)	Percent of median monthly discharge, 1941–70	Change in discharge from previous month (percent)	Discharge near end of month		
							(cfs)	(mgd)	Date
1–0140	St. John River below Fish River at Fort Kent, Maine.	5,690	9,397	14,950	72	+528	61,000	39,000	30
1–3185	Hudson River at Hadley, N.Y	1,664	2,791	9,784	115	+194	10,000	6,460	30
1–3575	Mohawk River at Cohoes, N.Y	3,456	5,450	16,158	126	+79	.....	.....	.....
1–4635	Delaware River at Trenton, N.J	6,780	11,360	23,337	110	0	10,400	6,720	27
1–5705	Susquehanna River at Harrisburg, Pa.	24,100	33,670	82,450	119	-14	47,400	30,600	25
1–6465	Potomac River near Washington, D.C.	11,560	[1] 10,640	16,300	94	-63	9,290	6,000	30
2–1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	4,847	7,967	137	-26	36,000	23,000	30
2–1310	Pee Dee River at Peedee, S.C	8,830	9,098	10,200	79	-34	7,270	4,700	26
2–2260	Altamaha River at Doctortown, Ga.	13,600	13,380	12,060	50	-48	14,300	9,240	27
2–3205	Suwannee River at Branford, Fla	7,740	6,775	10,800	105	-32	9,190	5,940	27
2–3580	Apalachicola River at Chattahoochee, Fla.	17,200	21,690	26,000	82	-42	20,100	13,000	28
2–4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	21,700	11,190	31	-69	5,750	3,720	28
2–4895	Pearl River near Bogalusa, La	6,630	8,533	7,380	57	-38	4,430	2,860	30
3–0495	Allegheny River at Natrona, Pa	11,410	[1] 18,700	7,177	20	-77	25,600	16,500	25
3–0850	Monongahela River at Braddock, Pa.	7,337	[1] 11,950	17,090	93	-45	16,300	10,500	25
3–1930	Kanawha River at Kanawha Falls, W.Va.	8,367	12,370	16,438	102	-58	7,410	4,790	24
3–2345	Scioto River at Higby, Ohio	5,131	4,337	10,317	139	-50	11,100	7,170	25
3–2945	Ohio River at Louisville, Ky[2]	91,170	110,600	163,400	85	-45	156,000	101,000	24
3–3775	Wabash River at Mount Carmel, Ill.	28,600	26,310	69,490	150	-14	62,000	40,000	30
3–4690	French Broad River below Douglas Dam, Tenn.	4,543	[1] 6,528	5,746	61	-56	.....	.....	.....
4–0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[2]	6,150	4,142	3,807	57	+36	.....	.....	.....
02MC002 (4–2643.31)	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[3]	299,000	239,100	303,600	121	+2	311,000	201,000	30
050115	St. Maurice River at Grand Mere, Quebec.	16,300	24,900	16,700	40	+182	34,600	22,400	28
5–0825	Red River of the North at Grand Forks, N. Dak.	30,100	2,439	30,110	340	+1,119	6,500	4,200	30
5–3300	Minnesota River near Jordan, Minn	16,200	3,306	12,500	157	+191	12,510	8,090	24
5–3310	Mississippi River at St. Paul, Minn	36,800	[1] 10,230	35,100	129	+252	33,200	21,500	23
5–3655	Chippewa River at Chippewa Falls, Wis.	5,600	5,062	10,317	105	+374	.....	.....	.....
5–4070	Wisconsin River at Muscoda, Wis	10,300	8,457	13,896	91	+94	.....	.....	.....
5–4465	Rock River near Joslin, Ill	9.520	5,288	10,700	128	+67	8,800	5,690	30
5–4745	Mississippi River at Keokuk, Iowa	119,000	61,210	141,000	120	+128	130,000	84,000	30
5–4855	Des Moines River below Raccoon River at Des Moines, Iowa.	9,879	3,796	7,233	142	+48	5,320	3,440	30
6–2145	Yellowstone River at Billings, Mont.	11,795	6,754	4,617	126	+16	4,200	2,700	30
6–9345	Missouri River at Hermann, Mo	528,200	78,480	176,000	184	+13	170,000	110,000	26
7–2890	Mississippi River at Vicksburg, Miss.[4]	1,144,500	552,700	1,123,400	114	+48	820,000	530,000	30
7–3310	Washita River near Durwood, Okla	7,202	1,379	763	71	+28	320	210	30
8–2765	Rio Grande below Taos Junction Bridge, near Taos, N. Mex.	9,730	732	297	45	-31	305	197	30
9–3150	Green River at Green River, Utah	40,600	6,369	7,546	111	+86	7,500	4,850	30
11–4255	Sacramento River at Verona, Calif	21,257	18,370	34,080	152	-29	33,200	21,500	27
13–2690	Snake River at Weiser, Idaho	69,200	17,670	26,780	127	+46	29,500	19,100	26
13–3170	Salmon River at White Bird, Idaho	13,550	11,060	15,240	145	+92	13,300	8,600	26
13–3425	Clearwater River at Spalding, Idaho	9,570	15,320	20,960	72	-9	17,000	11,000	26
14–1057	Columbia River at The Dalles, Oreg.[5]	237,000	194,000	235,300	105	+72	.....	.....	.....
14–1910	Willamette River at Salem, Oreg	7,280	23,370	15,800	55	+8	17,800	11,500	26–30
15–5155	Tanana River at Nenana, Alaska	25,600	24,040	8,513	125	+27	15,000	9,700	30
8MF005	Fraser River at Hope, British Columbia.	83,800	95,300	68,500	116	+116	90,000	58,000	27

[1] Adjusted.

[2] Records furnished by Corps of Engineers.

[3] Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.

[4] Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.

[5] Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

*The U.S. station numbers as listed in this table are in a shortened form previously in use, and used here for simplicity of tabular and map presentation. The full, correct number contains 8 digits and no punctuation marks. For example, the correct form for station number 1–3185 is 01318500.

DISSOLVED SOLIDS AND WATER TEMPERATURES FOR APRIL AT DOWNSTREAM SITES ON SIX LARGE RIVERS

Station number	Station name	April data of following calendar years	Stream discharge during month	Dissolved-solids concentration during month[a]		Dissolved-solids discharge during month[a]			Water temperature during month[b]		
			Mean (cfs)	Minimum (mg/L)	Maximum (mg/L)	Mean	Minimum	Maximum	Mean, in °C	Minimum, in °C	Maximum, in °C
						(tons per day)					
	NORTHEAST										
01463500	Delaware River at Trenton, N.J. (Morrisville, Pa.)	*1978	23,030	83	121	3,660	2,600	4,600	11.0	9.0	13.5
		1945–77	21,890	46	113	.....	1,240	12,300	.....	3.0	22.5
		(Extreme yr)		(1962)	(1964)		(1966)	(1960)			
			[c]21,180								
04264331	St. Lawrence River at Cornwall, Ontario, near Massena, N.Y.	1978	293,000	166	167	132,000	126,000	145,000	2.0	.5	4.5
		1976–77	290,800	164	168	130,000	118,000	146,000	4.0	2.0	6.5
		(Extreme yr)		(1977)	(1976)		(1977)	(1976)			
	median streamflow at Ogdensburg, N.Y.		[c]250,500								
	SOUTHEAST										
07289000	Mississippi River at Vicksburg, Miss.	1978	1,123,000	199	228	629,000	506,000	728,000	11.0	7.0	15.0
		1976–77	746,400	155	238	367,500	291,000	457,000	17.0	14.5	20.0
		(Extreme yr)		(1977)	(1976)		(1976)	(1977)			
			[c]981,200								
	WESTERN GREAT LAKES REGION										
03612500	Ohio River at lock and dam 53, near Grand Chain, Ill. (25 miles west of Paducah, Ky.; streamflow station at Metropolis, Ill.)	1978	413,300	154	239	.....	131,000	324,000	.....	10.5	16.5
		1955–77	454,000	117	282	.....	22,400	462,000	.....	6.5	19.0
		(Extreme yr)		(1957)	(1969)		(1976)	(1975)			
			[c]450,800								
	MIDCONTINENT										
06934500	Missouri River at Hermann, Mo. (60 miles west of St. Louis, Mo.)	1978	173,000	222	277	115,000	73,400	168,000	12.0	9.0	15.0
		1976–77	74,250	194	433	67,000	41,400	143,000	15.0	9.5	20.0
		(Extreme yr)		(1977)	(1976)		(1977)	(1976)			
			[c]95,600								
	WEST										
14128910	Columbia River at Warrendale, Oreg. (streamflow station at The Dalles, Oreg.)	1978	231,300	96	105	65,500	51,100	77,100	9.5	8.5	10.0
		1976–77	185,500	85	127	51,600	22,300	90,500	9.0	7.0	11.5
		(Extreme yr)		(1976)	(1977)		(1977)	(1976)			
			[c]190,600								

[a]Dissolved-solids concentrations when not analyzed directly, are calculated on basis of measurements of specific conductance.
[b]To convert °C to °F: [(1.8 X °C) + 32] = °F.
[c]Median of monthly values for 30-year reference period, water years 1941–70, for comparison with data for current month.
*Dissolved solids and water temperatures are for 12 days only (April 19–30).

ALASKA

Streamflow generally increased seasonally throughout most of Alaska and was above the normal range at all index stations except Gold Creek near Juneau. The above-normal streamflow trend was attributed to snowmelt runoff—earlier than usual this year as a result of above-normal temperatures during the month. In south-central Alaska, high carryover flow from March held monthly mean discharge in Kenai River at Cooper Landing in the above-normal range for the 3d consecutive month.

Ground-water levels in the confined aquifers in the Anchorage area declined 1 to 3 feet as a result of increased pumping and a continuation of the normal winter decline. Shallow water table wells rose in direct response to the early spring breakup.

HAWAII

On the island of Maui, monthly mean discharge at the index station, Honopou Stream near Huelo, decreased and remained in the below-normal range for the 3d consecutive month and was 37 percent of median. On the island of Oahu, monthly mean flow at the index station, Kalihi Stream near Honolulu, increased to 65 percent of median and was in the normal range after 6 consecutive months of below-normal flow. Elsewhere in the State, on the islands of Hawaii and Kauai, streamflow also increased and was in the normal range.

On Guam, in the Mariana Islands, monthly mean flow increased in Ylig River near Yona and was in the normal range after three consecutive months of below-normal flows.

METRIC EQUIVALENTS OF UNITS USED IN THE WATER RESOURCES REVIEW

(Round-number conversions, to nearest four significant figures)

1 foot = 0.3048 meter 1 mile = 1.609 kilometers
1 acre = 0.4047 hectare = 4,047 square meters
1 square mile (sq mi) = 259 hectares = 2.59 square kilometers (sq km)
1 acre-foot (ac-ft) = 1,233 cubic meters
1 million cubic feet (mcf) = 28,320 cubic meters
1 cubic foot per second (cfs) = 0.02832 cubic meters per second = 1.699 cubic meters per minute
1 second-foot-day (cfsd) = 2,447 cubic meters
1 million gallons (mg) = 3,785 cubic meters = 3.785 million liters
1 million gallons per day (mgd) = 694.4 gallons per minute (gpm) = 2.629 cubic meters per minute = 3,785 cubic meters per day

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WATER RESOURCES REVIEW

April 1978

Based on reports from the Canadian and U.S. field offices; completed May 11, 1978

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EXPLANATION OF DATA

Cover map shows generalized pattern of streamflow for April based on 20 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for April 1978 is compared with flow for April in the 30-year reference period 1941–70. Streamflow is considered to be *below the normal range* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for December is considered to be *above the normal range* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being *within the normal range.* In the Water Resources Review the median is obtained by ranking the 30 flows of the reference period in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the median.

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the April flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of April. Water level in each key observation well is compared with average level for the end of April determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels,* unless described otherwise, are from the end of March to the end of April.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. Issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Reston, Virginia 22092.

EFFECTIVENESS OF PILOT CONNECTOR WELL IN ARTIFICIAL RECHARGE OF THE FLORIDAN AQUIFER IN WESTERN ORANGE COUNTY, FLORIDA

The abstract, location map, and diagram below are from the report, *Effectiveness of pilot connector well in artificial recharge of the Floridan aquifer in western Orange County, Florida,* by Frank A. Watkins, Jr.: U.S. Geological Survey Water Resources Investigations 77-112, 28 pages, 1977. This report may be purchased for $4.50 (microfiche edition, $3.00) from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, specifying no. PB-278 054/AS (check or money order payable to National Technical Information Service).

ABSTRACT

A connector well pilot installation, in continuous operation in western Orange County (fig. 1) since December 4, 1970, was transferring water from the lower of two shallow sand aquifers to the Floridan aquifer (fig. 2) at a rate of 13 gallons per minute when measured on September 23, 1971. The recharge water is untreated and analyses show it to be chemically and physically compatible with the water in the Floridan aquifer. The temperatures of the recharging and receiving waters were identical, 23°C.

The transfer of water from the lower sand aquifer to the Floridan aquifer caused only a small buildup of artesian pressure in the Floridan aquifer but it lowered the artesian head 4 feet in the lower sand aquifer near the well which supplied the recharge water. Water levels in the upper sand aquifer were not affected, probably because of the low permeability of an intervening hardpan layer. However, after six auger holes back-filled with sand connected the two sand aquifers on April 5, 1972, a rise of water levels in the lower sand aquifer was noted.

The principal chemical and physical effects on the water in the Floridan aquifer were a general improvement in chemical quality and an increase in color. The color may decrease as more water moves through the sand aquifer and the material responsible for the high color is removed by flushing.

The results indicate the technical feasibility of connector wells to artificially recharge the Floridan aquifer. However, in areas that are hydrologically similar to the installation in western Orange County, some modification in the design and operation of connector wells might be considered to improve their efficiency.

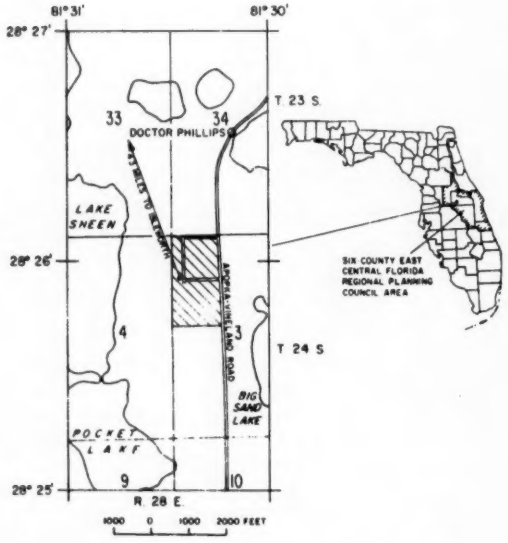

Figure 1.——Location of connector well pilot study site (shaded area) near Doctor Phillips.

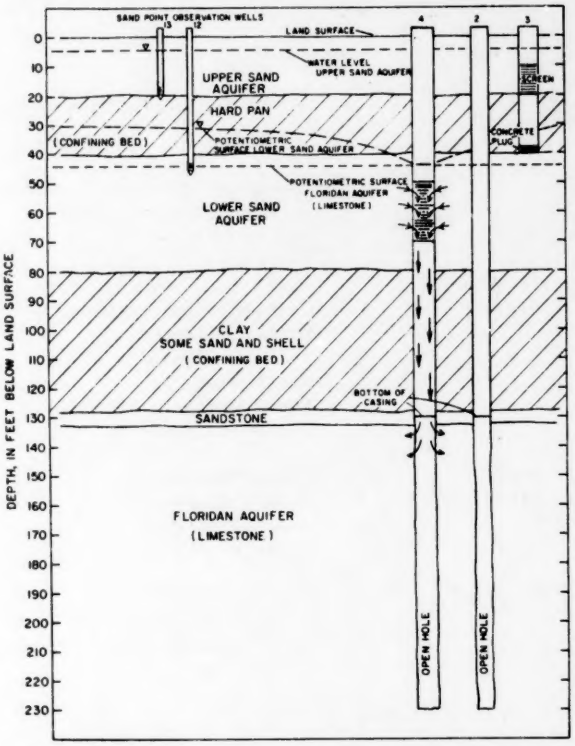

Figure 2.——Diagram showing water levels in the three water-bearing zones at the connector well site on February 2, 1971, after the connector well had been in operation for 61 days.

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